



Rewarding Learning

ADVANCED  
General Certificate of Education  
2023

Centre Number

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Candidate Number

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## Life and Health Sciences

Assessment Unit A2 3

*assessing*

Medical Physics

**MV24**

**[AZ031]**

**MONDAY 19 JUNE, MORNING**

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### **Time**

1 hour 45 minutes, plus your additional time allowance.

### **Instructions to Candidates**

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

Write your answers in the spaces provided in this question paper.

Answer **all eight** questions.

## Information for Candidates

The total mark for this paper is 100.

Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.

You may use an electronic calculator.

Quality of written communication will be assessed in question **6**.

1 Blood pressure and heart rate are often measured and monitored as they are physiological readings which can indicate the health of a patient.

(a) (i) What is **blood pressure**? [1 mark]

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(ii) What is heart rate? [1 mark]

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(iii) State the values above which blood pressure is considered too high in a normal adult. [2 marks]

Include the units of blood pressure with your answer.

Values \_\_\_\_\_

Units \_\_\_\_\_

(iv) A patient who exhibits **low** blood pressure over a long period of time may be in danger of suffering organ damage due to organs not receiving enough blood.

Suggest a danger associated with prolonged **high** blood pressure.  
[1 mark]

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**(c)** As people age their normal blood pressure changes.

Blood pressure readings can also change depending on the time of day and daily activities.

Suggest one other factor which may affect blood pressure. [1 mark]

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2 People suspected of having a sleep disorder may have their brainwaves monitored.

(a) (i) What is the **name** of the type of scan which monitors brainwaves?  
[1 mark]

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(ii) How is the scan in (i) carried out?  
[1 mark]

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Brainwaves are identified by the number of waves in one second, known as their frequency.

(iii) State one type of brainwave likely to be observed in patients as they sleep for a number of hours.

State the frequency of these brainwaves. [2 marks]

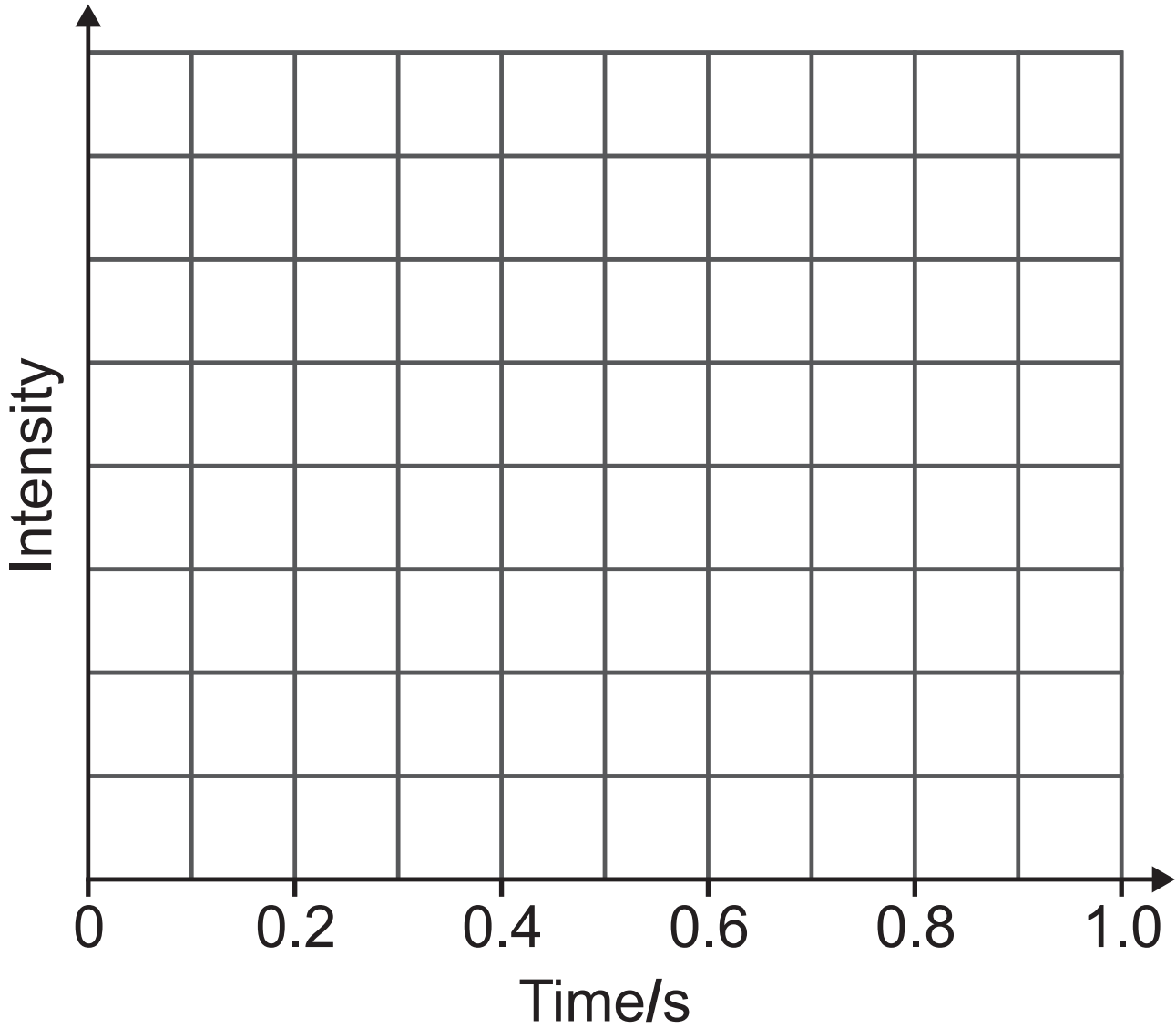
brainwave: \_\_\_\_\_ frequency: \_\_\_\_\_ Hz

**(iv)** Suggest one instruction a patient would be given in advance to prepare for the brainwave scan to investigate sleep disorder. Explain your answer. [2 marks]

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**(b) (i)** On the graph below, sketch a typical brainwave trace showing beta waves.  
[2 marks]



**(ii)** What activity might a patient be asked to perform if beta waves are to be observed? [1 mark]

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**(c)** CT and MRI are two important imaging techniques that can also be used to study the brain.

**(i)** The letters MRI stand for magnetic resonance imaging.

What do the letters CT stand for?  
[1 mark]

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**(ii)** What are the waves used in a CT scan and an MRI scan? [2 marks]

CT scan: \_\_\_\_\_

MRI scan: \_\_\_\_\_

**(iii)**What does a CT brain scan show and how is this different from a brainwave scan? [2 marks]

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**(iv)**Identify the potential risks to patients associated with MRI and CT scans. [2 marks]

MRI: \_\_\_\_\_

CT: \_\_\_\_\_

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A cyclist involved in a road traffic collision is admitted to the accident and emergency department of a hospital.

The cyclist arrives unconscious and is suspected of having a brain bleed.

If bleeding in the brain is left untreated, even for a short time, it could cause brain swelling and permanent brain damage.



3 (a) A physiological measurement taken by a medical practitioner, to indicate how well the body is functioning, is body temperature.

(i) Compare and contrast the use of a **contactless thermometer** and a **tympanic thermometer** to measure body temperature.

Include the following information in your answer:

- how each thermometer works; and
- how each thermometer is used to measure body temperature accurately.

How a contactless and a tympanic thermometer work: [2 marks]

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How a contactless and a tympanic thermometer are used to measure body temperature: [2 marks]

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(ii) State **two** advantages of using both contactless and tympanic thermometers compared to using an oral digital thermometer. [2 marks]

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**(b)** Although more expensive, the contactless thermometer is the most useful thermometer to use in a busy accident and emergency department.

Suggest two reasons why the **contactless** thermometer is preferred over all other types of thermometer in this situation. [2 marks]

1. \_\_\_\_\_

2. \_\_\_\_\_

4 (a) A patient has been referred for a scan that uses a nuclear isotope.

(i) Suggest a medical reason why a person might be referred for this type of scan. [1 mark]

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(ii) Suggest a radiopharmaceutical used in medical imaging and state the type of radiation it emits. [2 marks]

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(iii) Describe the procedure that would be carried out on the patient. [3 marks]

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**(b)** Below is a summary of the advice literature given to a patient before the scan.

- The patient may bring a companion to the hospital, but must not bring children or pregnant women.
- Young children may not sit in close contact with the patient, e.g. on the patient's lap, for the remainder of the day after the scan.
- After the scan the patient is advised to drink plenty of fluids and flush the toilet twice after use.

**(i)** Explain in detail why children and pregnant women are not permitted to accompany the patient into the hospital for a scan that uses a nuclear isotope. [3 marks]

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**(ii)** If it is initially unsafe for young children to be near a patient who has undergone a scan that uses a radioactive isotope, explain why it is safe the following day. [2 marks]

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**(iii)** Define **biological half-life**. [2 marks]

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**(iv)** Explain how biological half-life is affected if the patient drinks plenty of fluids after the scan. [2 marks]

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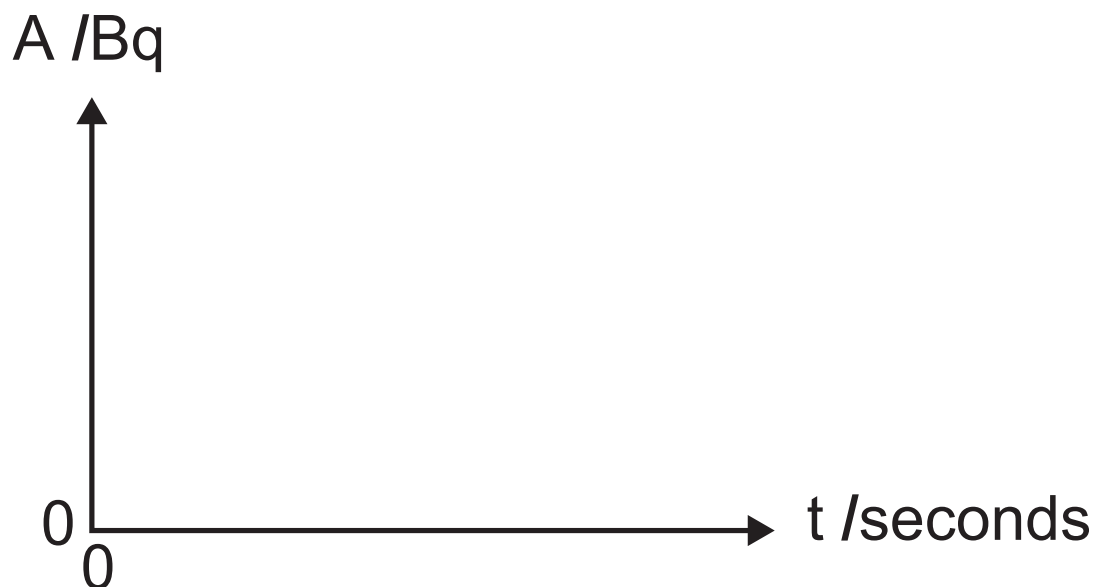
5 (a) A radioactive isotope decays according to the equation  $A = A_0 e^{-\lambda t}$ .

(i) What does the symbol  $\lambda$  represent in this equation? [1 mark]

$\lambda$  : \_\_\_\_\_

(ii) Sketch a graph below of activity  $A$  plotted against time  $t$ .

Mark the symbol  $A_0$  on the graph. [2 marks]



The radioactive isotope has a half-life of 14.3 days.

**(iii)** Define the **half-life** of a radioactive isotope. [2 marks]

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**(iv)** Calculate the value of  $\lambda$  and include the units. [4 marks]

**You are advised to show your working.**

$\lambda =$  \_\_\_\_\_ units = \_\_\_\_\_

(v) Calculate the percentage decrease in the value of activity after 6 weeks have passed. [4 marks]

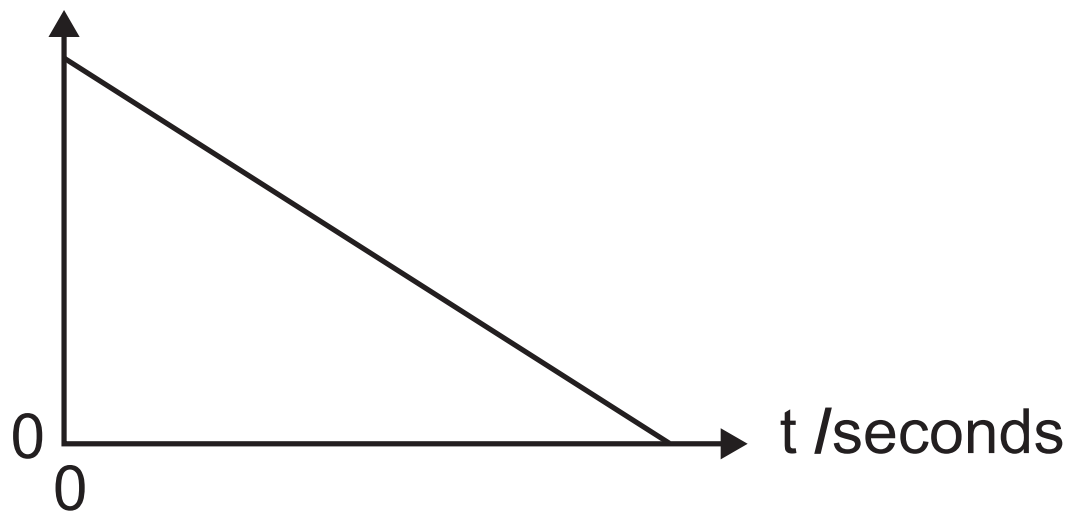
**You are advised to show your working.**

Percentage decrease = \_\_\_\_\_ %

- (b)** Another equation used to describe the decay of a radioactive isotope is  $\ln A = \ln A_0 - \lambda t$ .

A graph of  $\ln A$  against  $t$  is shown below.

$\ln (A / \text{Bq})$



- (i)** How can the initial activity be determined from the graph of  $\ln A$  against  $t$ ? [2 marks]

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(ii) The equation of the straight line representing the graph of  $\ln A$  against  $t$  is:

$$\ln A = -0.037t + 11$$

Use this information to show the initial activity of the radioactive source is approximately 60 kBq. [1 mark]

(iii) Calculate the value of the activity after 60 seconds. [2 marks]

**You are advised to show your working.**

Activity after 60 seconds = \_\_\_\_\_ Bq

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**(Questions continue overleaf)**

**6** Cancer in the stomach can block food from entering and leaving the stomach.

This can cause sickness and pain.

One of the methods of treating this involves burning away some of the cancer cells to create an opening which makes it easier for food to enter the stomach.

This treatment can be carried out using an endoscope.

Discuss this type of endoscopic procedure.  
[8 marks]

Include the following in your discussion:

- how the design of the endoscope enables a surgeon to see inside the stomach without creating an incision in the abdomen;
- the physical principle that allows light to travel along the optical fibres;
- how the endoscope can be used to burn the cancer cells; and

- the advantages for the patient of using an endoscope to perform small operations compared to open surgery.

**Quality of written communication will be assessed in this question.**

## **Design of the endoscope**

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# Physical principle

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# Burning the cancer cells

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# Advantages

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**(Questions continue overleaf)**

**7** A radioactive source in a school laboratory emits **more than one type** of radiation.

You are asked to describe an experiment which could be carried out in the laboratory to investigate which types of radiation are emitted from the source.

**(i)** Complete the diagram opposite by labelling the apparatus that would be used for this experiment. [2 marks]

On the diagram, suggest a suitable distance between the radioactive source and the Geiger Muller tube that would allow all types of radiation to be detected.

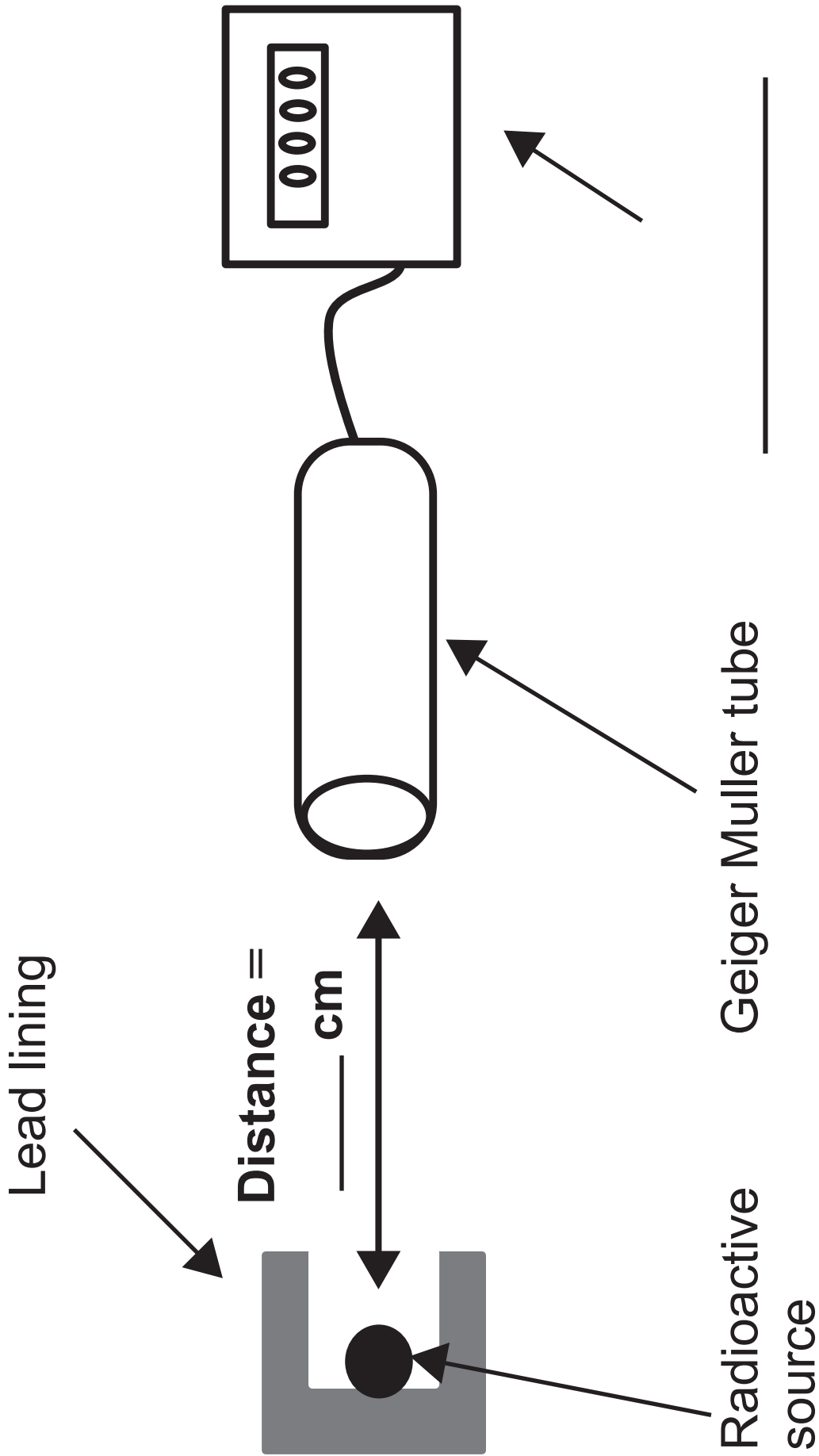


Diagram not drawn to scale



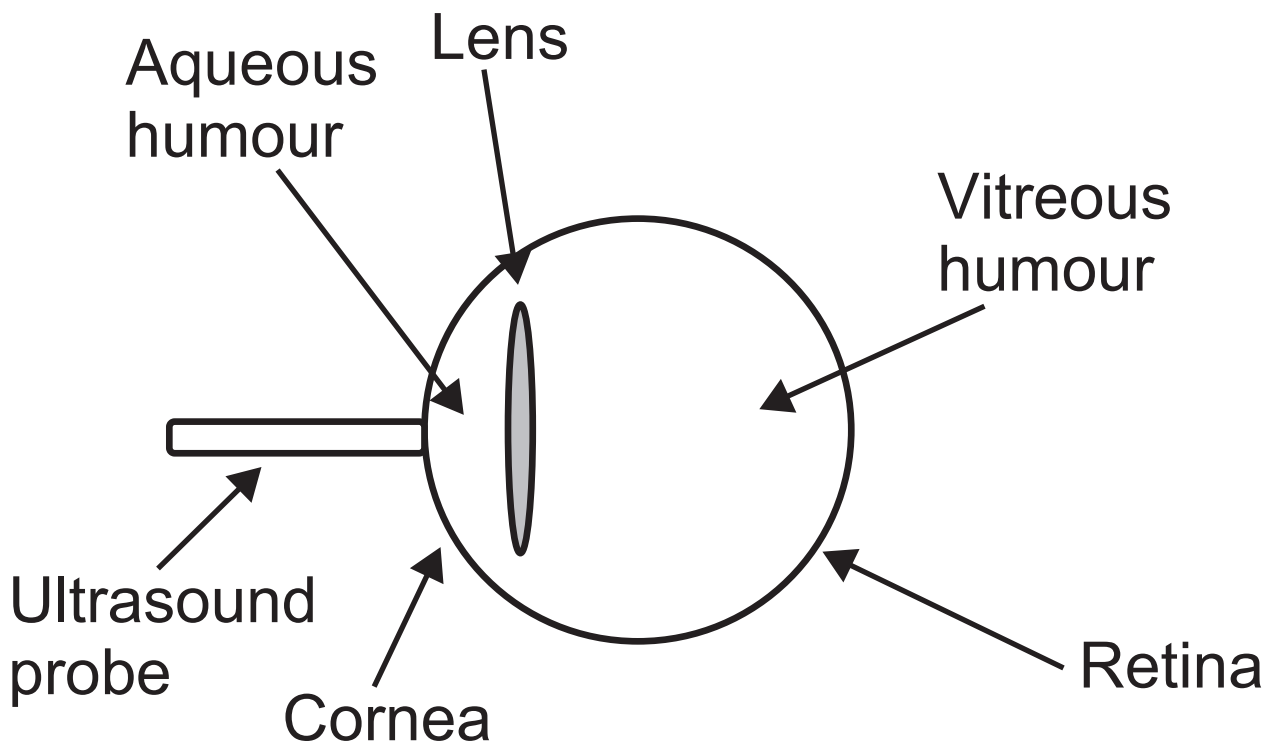
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**(Questions continue overleaf)**

- 8 Ultrasound scans can be used in ophthalmology, a branch of medicine dealing with eye disorders.

The diagram below shows a simplified sketch of the human eye.

During an ultrasound examination the ultrasound probe is placed on the cornea and the pulses of ultrasound transmitted into the eye are reflected from the various structures inside the eyeball.



An ultrasound A scan can be used to determine the length of an eyeball. An ultrasound B scan can be used to help diagnose a detached retina.

- (i) What is the difference between the images produced by an ultrasound A scan and an ultrasound B scan?  
[2 marks]

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**(ii)** Suggest the ultrasound frequency used to study the eye.

Explain your answer in detail.

Frequency [1 mark]

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Explanation [2 marks]

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**(Questions continue overleaf)**

**(iii)** The table below shows some speeds at which the ultrasound travels through biological material of different densities in the eye.

<b>Biological material</b>	<b>Speed of ultrasound/ kms<sup>-1</sup></b>	<b>Density/ kgm<sup>-3</sup></b>
Aqueous humour	1.50	1000
Lens	1.64	1120

By first finding the specific acoustic impedance of the materials in the aqueous humour and the lens, calculate the intensity reflection coefficient for ultrasound travelling from the aqueous humour to the lens. [7 marks]

**You are advised to show your working.**

Intensity  
reflection coefficient = \_\_\_\_\_

## SOURCES

Q7 . . . . Source: © *Principal Examiner*

Q8 . . . . Source: © *Principal Examiner*

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**This is the end of the  
question paper**

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Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
<b>Total Marks</b>	

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